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Hydroxyl radical variability and its influence on recent methane growth inferred from methyl chloroform trends

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Tropospheric hydroxyl radical (OH) concentrations can be inferred using long-term trends in methyl chloroform (CH_3CCl_3). However, it has long been known that inaccuracies in the assumed emissions of CH_3CCl_3 have the potential to induce significant systematic errors in the OH levels derived using this approach. To address this, we present a Bayesian study in which uncertain parameters within a model of CH_3CCl_3 emissions were explored using atmospheric CH_3CCl_3 data. This allows us to bring the model into consistency with informative features, such as the observed inter-hemispheric gradient, and propagate any remaining uncertainties through to our OH estimates. Using this approach, we find a maximum-likelihood solution that indicates an increase in OH concentrations of around 10% between the late 1990s and mid-2000s, and a subsequent fall of similar magnitude from the mid-2000s to 2014. However, significant uncertainties remain such that a "constant OH" trajectory is also plausible from our estimation framework. When these uncertainties are considered, the probability of some level of decline in OH between 2007 and 2014 is between 64 and 70%. By including CH_4 and δ^{13}C-CH_4 observations in our inversion, we can propagate these OH concentrations and uncertainties through to top-down estimates of CH_4 emissions. Our maximum-likelihood solution does not require a pause and then sudden growth in CH_4 emissions around the years 2000 and 2007, respectively, as has been suggested elsewhere. Rather, emissions increase relatively gradually over the last two decades. Furthermore, this solution suggests that OH changes have contributed to the recent decline in δ^{13}C-CH_4 and the growth in ethane. However, the uncertainties in our CH_4 inversion, which derive largely from the OH estimates, are significant. Without careful consideration of the above OH uncertainties, it would be possible to draw over-confident conclusions about the causes of recent CH_4 changes.